INTEGRATED PEST AND DISEASE MANAGEMENT IN GREENHOUSE CROPS

Developments in Plant Pathology

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Integrated Pest and Disease Management in Greenhouse Crops

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FOREWORD

The International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), established in 1962, is an intergovernmental organization of 13 countries: Albania, Algeria, Egypt, France, Greece, Italy, Lebanon, Malta, Morocco, Portugal, Spain, Tunisia and Turkey.

Four institutes (Bari, Italy; Chania, Greece; Montpellier, France; and Zaragoza, Spain) provide postgraduate education at the Master of Science level. CIHEAM promotes research networks on Mediterranean agricultural priorities, supports the organization of specialized education in member countries, holds seminars and workshops bringing together technologists and scientists involved in Mediterranean agriculture and regularly produces diverse publications including the series *Options Méditerranéennes*. Through these activities, CIHEAM promotes North/South dialogue and international co-operation for agricultural development in the Mediterranean region.

Over the past decade, the Mediterranean Agronomic Institute of Zaragoza has developed a number of training and research-supporting activities in the field of agroecology and sustainability of agricultural production systems. Some of these activities have been concerned with the rational use of pesticides and more particularly with the implementation of integrated control systems in order to gain in efficacy and decrease both the environmental impact and the negative repercussions for the commercialization of agricultural products. Stemming from the organization of a course on "Integrated Pest and Disease Management in Protected Crops", and as a consequence of the enthusiasm of the lecturers who took part in the course and its scientific co-ordinators, we decided to publish a book based on the contents of the course to provide professionals interested in updating their knowledge with a comprehensive vision of the state of the art of IPM.

Several objective reasons convinced us of our decision. On one hand, the growing economic and social importance of protected crops in the countries of the Mediterranean area. On the other, the fragility of the ecosystems on which they are grown, very often close to areas of urban concentration and tourist development. Therefore, integrated management must be incorporated into the present production systems and appropriate research and experimentation programmes must be developed in order to generate a pest and disease control technology adapted to the ecological conditions and predominant species in each circumstance. We felt that this book could contribute in this task. The Mediterranean Agronomic Institute of Zaragoza has experience from similar publications arising from their professional-training programmes and this also encouraged us to undertake this ambitious project.

The magnitude of our ambition only became clear to us when, compiling the book, we were confronted with the large number of authors, their diverse specialities and origins (from researchers to extensionists, from both the public sector and private firms), and the multidisciplinary nature of the approach, addressing both basic and applied aspects. Accommodating such diversity into the different parts of the book has been our most difficult task. Therefore, it is with great satisfaction and gratitude that we acknowledge and thank the editors, R. Albajes, M.L. Gullino, J.C. van Lenteren and Y. Elad for their inspired and efficient work in orienting and co-ordinating the book. Likewise, we would like to express our gratitude to each and every one of the 62 authors for their contribution to this team effort.

The design and development of this book are yet another example of the results that can be achieved through co-operation, and as such, contributes to CIHEAM's objective of promoting co-operation for the development of the agro-food sector in the

Mediterranean area. We hope this example will encourage the same co-operative attitude amongst readers.

Finally we should like to express our satisfaction of the efficacious collaboration from Kluwer Academic Publishers and wish to thank them for their interest in this project.

Miguel Valls
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PREFACE

This book originated from an international course that was organized on "Integrated Pest and Disease Management in Protected Crops" at the Mediterranean Agronomic Institute of Zaragoza of the CIHEAM. Thirteen guest speakers lectured to some thirty participants, and the idea of publishing the contributions to the course arose as a result of their enthusiasm. The project soon became more ambitious with the purpose of enriching the publication's objectives and contents. Thus, the variety of ways in which protected crops are cultivated world-wide demanded the collaboration, not only of European authors, but of authors from all those regions that have developed the greenhouse crop industry. Likewise it was necessary, on this occasion, to count on the multi-disciplinarity of integrated control, therefore new entomologists and plant pathologists working in different disciplinary environments, such as ecology, molecular biology, statistics, information systems and plant breeding, were incorporated into the project. It was also considered necessary to count on the collaboration of specialists from the public and private sectors involved in the different links of the chain necessary for the technological innovation of integrated control: researchers, extensionists, natural enemy producers, consultants. This diversity of authors is probably what we are most satisfied with as editors. Nevertheless, this has also complicated the edition work as we have tried to keep a maximum of homogeneity without falling into too much uniformity. As the basic elements of integrated control need to make use of local conditions favourable to pest and disease control, one cannot expect the points of view, practices, even scientific backgrounds to be common throughout all the chapters of the book when very often the authors work in areas which are geographically very different. Whenever possible, we have entrusted each chapter to authors whose activity and perspectives could be complementary: entomologists together with pathologists, from both public and private sectors, differentiated geographical areas, etc. It is our sincere belief that no text published to date has offered such a diverse yet integrated approach to pest and disease control in greenhouse crops.

The book opens with an initial chapter describing the scenario where integrated pest and disease control operates, that is, the greenhouse and its environment. Ensuing chapters provide the basic strategies and tactics of integrated control, with special reference to greenhouse crops. Further chapters include the different facets of biological pest and disease control – its scientific bases, its development in practice, its commercialization and quality control. The pre-eminence of biological control in the book is not surprising since without a doubt it is the cornerstone of integrated insect pest control and is also becoming increasingly more important in disease control. The concluding chapters of the book show us the present situation of integrated pest and disease control in the most important greenhouse crops world-wide. This final section opens with a chapter discussing the technology transfer process from research to the consumer; this chapter is by no means superfluous, as the lack of an efficient technology transfer is often the main cause of the slow adoption of integrated control.

This book is neither a manual nor a guide. We have attempted to provide post-graduate and professional readers already familiar with the subject, with a means to acquire deeper knowledge on integrated control of pests and diseases in greenhouse crops and furthermore suggest possible roads to take in future tasks. It is evident, however, that each situation and each problem requires a particular solution. Integrated control in greenhouses first developed in England and The Netherlands in the 60s. The success reached in both countries led the research, extension and application of this type of control system to become generalized throughout northern Europe in the 70s and 80s.

This experience, so positive in the North of Europe, stimulated the adaptation of integrated systems for other areas such as the Mediterranean, North America, Oceania and Asia at various rates and degrees of success. It has been shown that a mere transposition of northern European solutions is not valid in other parts of the world. Each new situation demands further research, development, extension, training and new forms of application. Without this local effort, it will be very difficult for integrated control to progress at a faster rate. We trust that this work will contribute to stimulating and guiding this effort.

We have many people to thank. The Mediterranean Agronomic Institute of Zaragoza organized and hosted the course that gave rise to this book and subsequently undertook the co-ordination of the edition and technical editing. Had we not been able to count on their experience, professionalism and enthusiasm, we would not have been able to embark on this endeavour. The participants in the mentioned course have also permitted us to enrich the content of this work with their suggestions and constructive criticism. The authors have shown at all times a great patience and comprehension on reacting to our requests and revisions with good will and wisdom. The IOBC/WPRS, "International Organization for Biological and Integrated Control of Noxious Animals and Plants, West Palaeartic Regional Section" likewise deserves a special mention of gratitude. In two of their working groups on "Integrated Control in Greenhouse Crops", these editors and many of the authors have been collaborating and continue to do so, thus facilitating the edition of the book.

To publish a book is an arduous task. The mere conviction of the need to divulge and teach what has been learnt from others and our own sense of duty can compensate such an undertaking. Fortunately, we are convinced that the effort of the hundred people who have collaborated, in one way or another, in this book has been worthwhile. Another decisive stimulant for this endeavour was the realization of the growing need to incorporate integrated systems of protection from arthropod pests and diseases for the thousands of hectares of protected crops in the world. Both the fruit, vegetable and ornamental plant markets and the technical and economic efficiency of crop protection require these integrated control systems.

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